John Clarke

A Second Book of Sets

1846

DISCOVERY PROGRAMMES

A Second Book of Sets

This programme has the following test record:

First tested with 15 children in 3 schools

After revision, tested with 92 children in 8 schools (6 junior, 2 secondary)

After further revision, tested with 15 children in 3 junior schools

Error rate on all frames = 6·3%

Post test, given two weeks after completion of programme, revealed a retention figure of 71·6%

1846
~~3720~~

DISCOVERY PROGRAMMES
General Editor: John Leedham, M.Ed.

A second book of sets

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Titles in this series will include

THE AIR WE BREATHE by John Leedham
A FIRST BOOK OF SETS by John Clarke
THE GEOMETRY OF THE POINT AND LINE
by Cyril Harries
THE SCARLET RUNNER by John Fieldhouse
AREA AND VOLUME by John Leedham and D. V. Parker
DON'T SMOKE! by R. W. Kind and John Leedham
THE WORLD OF NUMBER by Norman Beard
A FIRST BOOK OF FRACTIONS
A SECOND BOOK OF FRACTIONS
UNDERSTANDING NUMBER BASE
PLACE VALUE
} by John Clarke
UNDERSTANDING AND USING A CONTOUR MAP
by Kathleen Brooks

Printed in Great Britain by Lowe & Brydone (Printers) Ltd.

Introducing Discovery Programmes

Discovery Programmes are programmed books developed by practising teachers. They seek to introduce fresh material, or to put forward traditional material in a new way; they are intended to be a real adjunct to the work of the teacher. All have been carefully tested and have proved their worth under classroom conditions. The texts require a reading age of 10·4 or above; no previous knowledge of their subjects is needed.

Discovery Programmes are largely the result of experiments in programmed learning carried out by a group of teachers in the Leicestershire Education Authority. All programmes have been tested and retested in many schools in the locality and elsewhere, and the editor would like to express his appreciation of the help provided by the Director and Committee of the Leicestershire Education Authority.

"Programmed Learning is one of the most important new tools teachers have at their disposal. We are only at the beginning of exploring its full potential and I certainly will not attempt to guess how far it will take us. The important thing is to realise that it is a tool to be used by the teacher and not a substitute for him. A programme has the merit of infinite patience and it gives its undivided attention to the child who is using it. If it is a good one, it is subtle in providing the right doses of motivation."

Stewart C. Mason, M.A.
Director of Education, Leicestershire

To the Pupil

Anne was the first person to do the work in this programme and when she had finished she produced some of her own problems which could be solved by the use of Venn diagrams. This is one of her puzzles. I wonder if you can find the answers.

> At a Garden Fete, to win a bar of chocolate, a cup, or mug, or a saucer had to knocked off a shelf. If you succeeded, you won a bar of chocolate. If you knocked *any two* of the items off, you won a $\frac{1}{2}$-lb. box of chocolates, but if you knocked *all three pots off*, with the three balls you were allowed, you would receive a 1-lb. box of chocolates.
>
> 3 people knocked all three items off
> 7 people knocked a saucer and a mug off
> 5 people knocked a cup and saucer off
> 6 people knocked a mug and cup off
> 10 people altogether knocked off a cup
> 12 people altogether knocked off a mug
> 11 people altogether knocked off a saucer.
>
> (*a*) How many bars of chocolate were needed?
> (*b*) How many people's scores were recorded at this game?
> (*c*) How many $\frac{1}{2}$-lb. boxes of chocolates were needed?
> (*d*) How many 1-lb. boxes of chocolates were needed?

If you can work out the answers, well done! If you cannot, you should be able to when you have completed the programme and you should also be able to make up some problems of your own to puzzle your friends.

1846

Pre-test

1 A SET is a c———.

2 When we *name* a set we usually use a——— ———.

3 When a set is listed its members or e——— are written inside * * .

4 A set can be *described* by writing down what it is that is common to its members. This is the ——— ——— of the set.

5 Natural numbers are the numbers we use when we c———.

6 The sentence below should say, "2 is an element of the set of natural numbers".

$2 \ * \ \{1, 2, 3, 4, 5, \ldots\}$ Which sign is missing?

7 If set Y is a part of set Z, Y is a s——— of Z.

8 $Y \subset Z$. What does this mathematical sentence say?

9 If two sets are united, the result is another ———.

10 How many times is one element listed in a set: once, twice, or any number of times?

11 $A = \{1, 2, 3\}$ $B = \{3, 4, 5\}$

Write $A \cup B$ *using brackets.*

12 Draw a Venn diagram to show the UNION of sets E and F.

$E = \{p, q, r\}$ $F = \{r, s, t\}$

13 An intersection is a m——— p———.

14 The intersection of two sets is the c——— e———.

15 $G = \{2, 4, 6, 8\}$ $H = \{4, 8, 12, 16\}$

What is $G \cap H$?

16 I = the set of children with fair hair =
{Ian, Jane, Peter, John, Ann, Mary}
J = the set of children with brown eyes =
{Ann, Joan, Bill, John, Jim, Alan}

Draw a Venn diagram to find the answers to these questions:

How many children had fair hair *and* brown eyes?

17 Who had fair hair and brown eyes?

18 Who had brown eyes but dark hair?

19 How many children in the class had neither fair hair nor brown eyes? There were 16 children in the whole class.

20 A number of people was asked which were their favourite television programmes.

Three kinds of programmes were watched: sport, films and comedy shows.

15 people watched sport
12 people watched films
14 people watched comedy
5 people watched sport and films
6 people watched films and comedy
9 people watched comedy and sport
3 people watched all three kinds of programmes.

Draw a Venn diagram to answer the following questions:

How many people watched sport and films but *not* comedy?

21 How many people watched sport only?

22 How many people watched comedy only?

23 How many people watched any 2 programmes but not 3?

24 How many people were asked to give their favourite programmes?

25 How many people who liked comedy *also* liked *either* sport or films?

The answers to this test will be found at the back of the book.

To the Pupil

This is a programme. This is how it works:

1 Cut a piece of cardboard or paper just long enough and wide enough to cover this page from top to bottom and side to side, including the coloured margin.
This we call a *mask*.
Place it over the frame below this one.
Now write down in your notebook the answer to this question.
Is the coloured margin on the right—
1½ miles wide? 1½ inches wide?
To find out if you are right, pull down the mask until you can just see the answer printed in the margin.

---

2 Mark your answer. Your answer should always be written down before you check it.
This is because we LE * * N better if we try on our own.
Write down the word.
Move down the mask.

1
1½ INCHES

---

3 Check your answer.
Now you know how to use the programme.

2
LEARN

Before you read and answer any question, be sure that the next frames are covered by your mask

1 HERD, SWARM, TEAM, CREW, LITTER
There is something similar about all these words.
They all refer to COLLECTIONS of animals or people.
Here is another similar word—fl * * k. Can you complete it?
(Each asterisk, *, stands for one letter. Write out the whole word.)

ANSWER

---

2 Flock is a similar word. It might refer to a flock of sheep or a flock of birds.
Here is another similar type of word for you to complete,

fl * * t.

This refers to ships.

1
FLOCK

---

3 Here is another,

libr * * *.

This word refers to books.

2
FLEET

---

4 All the words we have been thinking about refer to COLLECTIONS.
Another word which means a COLLECTION is SET.
A SET **is** a collect * * *.

3
LIBRARY

---

5 A SET can be a collection of many kinds of things.
There is usually a good reason for a particular collection or * * * being put together.

4
COLLECTION

6 A family is a kind of set. The MEMBERS of the family belong to the set because they are related to each other.

The MEMBERS of a set are known as ELEMENTS.

MEMBERS means the same as ELE* * * * *.

5
SET

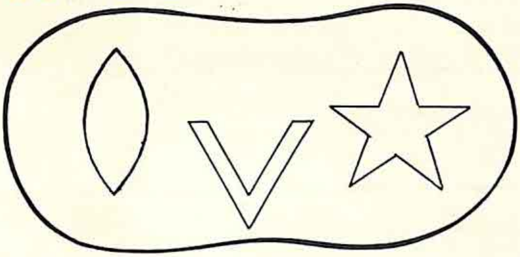
---

7 Something which belongs to a set is called an * * * ment.

6
ELEMENTS

---

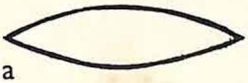
8 It is often necessary to decide whether or not an element belongs to a set. To do this, we must find what is common to the members of that set.



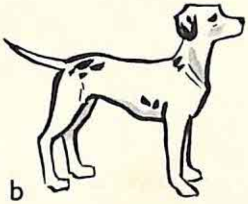
Here is a set of shapes.

The line (which is called a closed curve) round the elements shows they make a set.

Which of these two pictures is more likely to belong to the set, a or b?



a



b

7
ELEMENT

---

9 a was *the more likely* to belong to the set because we were given a SET OF SHAPES, not a set of animals.

To describe a set we say what it is that is common to its elements. We call this its CHARACTERISTIC PROPERTY.

(CHARACTERISTIC is pronounced *ca-rack-ter-ist-ick*.

PROPERTY is pronounced *prop-er-ti*.)

Copy the two words, characteristic property.

8
a

10 The word PROPERTY refers to a quality shown by a particular thing.
A property of sugar is that it is sweet.
A property of ice is that it is cold.
A property of iron is that it is h * * d.

9
CHARACTERISTIC PROPERTY

---

11 A quality or PROPERTY shown by a particular thing is CHARACTERISTIC of that thing.
It is characteristic of aeroplanes that they fly.
It is characteristic of grass that it is green.
It is characteristic of chalk that it is brittle.
It is characteristic of a needle that it is sh * * p.

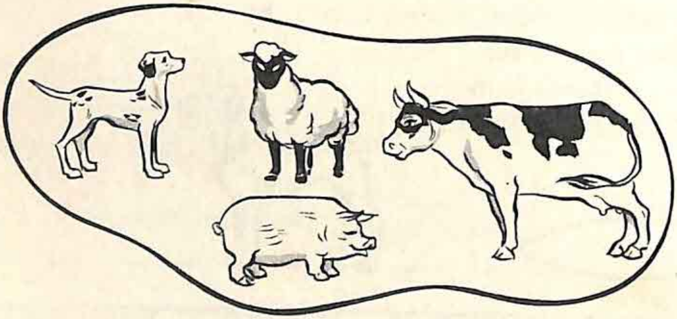
10
HARD

---

12 The CHARACTERISTIC PROPERTY of a SET tells us what quality is shown by all the ele * * * * * of that set.

11
SHARP

13

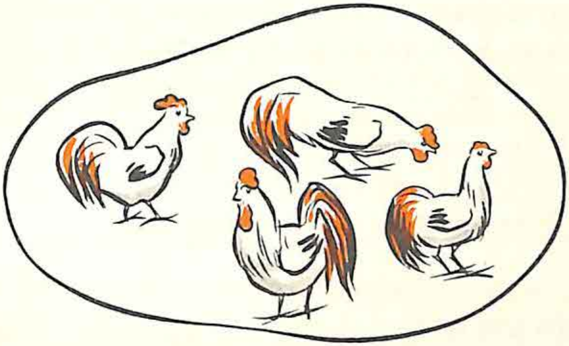


This is a set of animals.
The word ——— gives us the characteristic property of the set.

(A line stands for part of a word or sometimes for a whole word. Always write the whole word for your answer.)

12
ELEMENTS

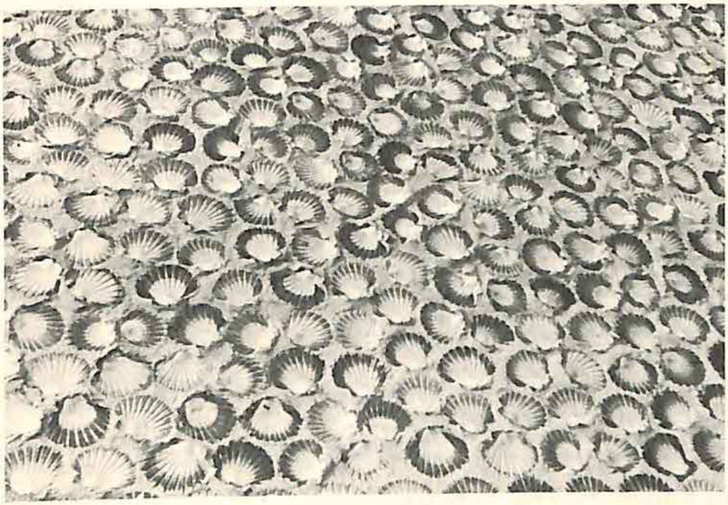
14



This is a —— of cockerels.
The word 'cockerels' gives us the char * * * * * * * * * *
property of the ——.

13
ANIMALS

15



This photograph shows a set of shells.
The characteristic p—— of this set is that the
elements are all ——.

14
SET:
CHARACTERIST
SET

16 A collection of elements is shown to be a set by the use of *curly brackets*, just as a set can be shown by the use of a *closed curve*.

(Queen of England) {Queen of England}

These examples both show the same set. You must read each example as:

THE SET OF THE QUEEN OF ENGLAND.

How many elements has this set?

15
PROPERTY:
SHELLS

---

17 The curly brackets stand for the words "the set of".

{toes on one foot}

This is read as: the set of toes on one foot.

How many elements has this set?

16
ONE OR 1

18

Here is John.
He is a boy.
He is one of the boys in the world.
What is this boy's name?

17
FIVE OR 5

---

19 We *describe* John by giving his CHARACTERISTIC PROPERTY.

What **is** John's characteristic property?

18
JOHN

---

20 Boys and girls are known by their names.
John is such a *name*.
To *name* a set we use a CAPITAL LETTER.
We use a CAPITAL LETTER to name a set just as we use JOHN to *name* a ——.

19
HE IS A BOY
(YOUR ANSWER
SHOULD MEAN
THIS)

21 $N = \{1, 2, 3, 4, 5, 6, \ldots\}$
$N = \{\text{natural numbers}\}$
The set in this frame has a name. What is its name?

20
BOY (OR MAN

---

22 $G = \{\text{Susan, Anne, Sheila, } \ldots\}$
What is the characteristic property of this set?

21
N

---

23 The numbers we use when we count are called NATURAL NUMBERS.
The ch———— p———— of these numbers is that they must be whole numbers such as 1, 2, 3 and 4.

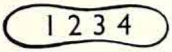
22
(ALL) GIRLS'
NAMES

---

24 **There is no end** to the NATURAL NUMBERS, so we say it is an INFINITE set. (INFINITE is pronounced *in-fin-it*.)
Is it possible to count or list the elements of an INFINITE set?

23
CHARACTERIS
PROPERTY

---

25 A = 

$B = \{1, 4, 3, 2\}$

Here are two different ways of showing the same set.

The order of the elements does not matter.
We say that A is the same as B, or A * B.
Replace * by a suitable sign.

24
NO

---

26 $N = \{\text{natural numbers}\}$
546 7 19 $22\frac{1}{2}$ 1000
One of these numbers could not be an element of N.
Which number is it?

25
=

---

27 $22\frac{1}{2}$ could not be an element of N in frame 26 because $22\frac{1}{2}$ is not a ———— ————.

26
$22\frac{1}{2}$

---

28 A ______ number must always be a whole number.

27
NATURAL OR
WHOLE
NUMBER

---

29 The word element begins with an e.
The sign we use to stand for the words "is an element of" is like an e. It is ∈.
∈ stands in place of "is an ______ of".

28
NATURAL

---

30 2 {natural numbers}
The mathematical sentence above should say, "Two is an element of the set of natural numbers."
Which sign is missing?

29
ELEMENT

---

31 2 ∈ {natural numbers}
Here is the complete mathematical sentence.
In frame 26 there was a number which could not be a member of the set of natural numbers.
This mathematical sentence could have been written using another sign.
$22\frac{1}{2} \notin$ {natural numbers}
This means, "$22\frac{1}{2}$ is NOT an element of ___ ___ ___ ______ ______.

30
∈

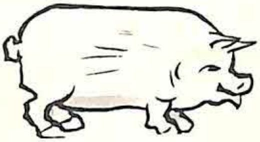
31
THE SET OF
NATURAL
NUMBERS

Review Section 1

To give you practice in using the terms and signs we have used so far in this book, a number of mathematical sentences follow. Look at each one very carefully and write whether the sentence is true or false (not true).

1 296 $\in$ {natural numbers}

2



$\in$ B

The characteristic property of B is that the elements are birds.

3 $X = \{2, 4, 6, 8\}$
The characteristic property of X is that it is made up of *all* the natural numbers less than 10.

4 hand $\notin$ {parts of the body}

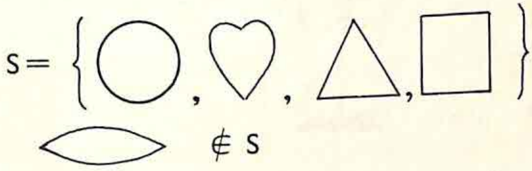
5 $N =$ {natural numbers}
N is an infinite set.

6 orange $\in$ {fruits which we eat}

7 16 $\in$ {numbers greater than 10 and less than 18}

8 8 $\notin$ {numbers less than 10}

9



Now check your answers with those below.

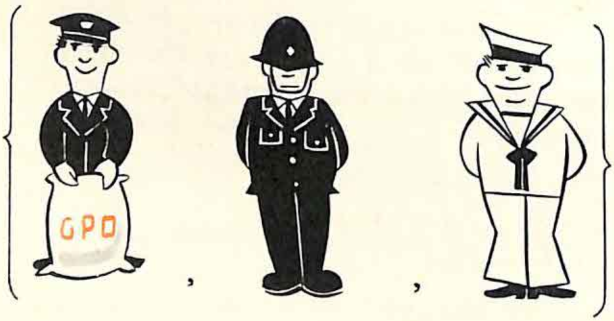
3 FALSE 7 TRUE 6 TRUE 1 TRUE
9 TRUE 8 FALSE 5 TRUE 4 FALSE
2 FALSE

32 P =

This is a set of men and women.
The name of this set is P.
The elements are a nurse, a postman, a typist, a policeman and a sailor.
Which elements of P are men?

---

33 M =



These three men, who are *part* of set P, can form a set on their own.
This set is called a SUBSET of P.
A SUBSET is p* * * of a set.

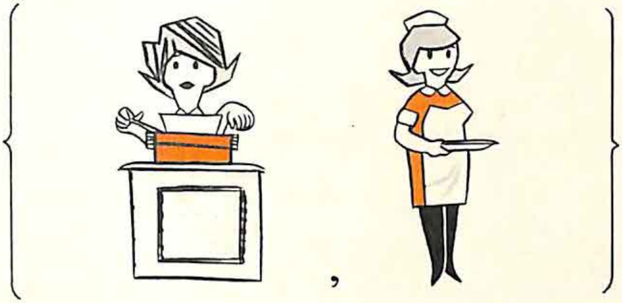
---

34 Which elements of P are women?

32
POSTMAN;
POLICEMAN
SAILOR

33
PART

35 W =



These two women also form a set which is a * * * set of P.

34
TYPIST;
NURSE

---

36 P is the name of the set of men and women.
M is the name of the set of men.
W is the name of the set of women.
(*a*) M is a SUBSET of *. } Write the NAMES of the sets.
(*b*) W is a SUBSET of *. }

35
SUBSET

---

37 ⊂ This sign is used for the words:
"is a subset of".
M⊂P is a mathematical sentence which is read as,
"M is a ——— of P."

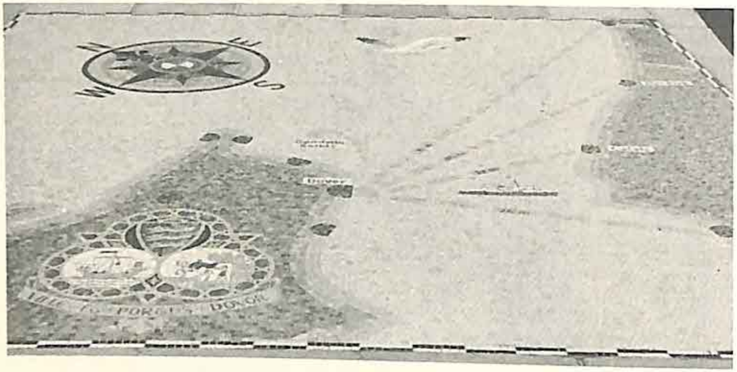
36
(*a*) P
(*b*) P

---

38 W⊂P This is also a mathematical sentence.
Write it out in full, using words.

37
SUBSET

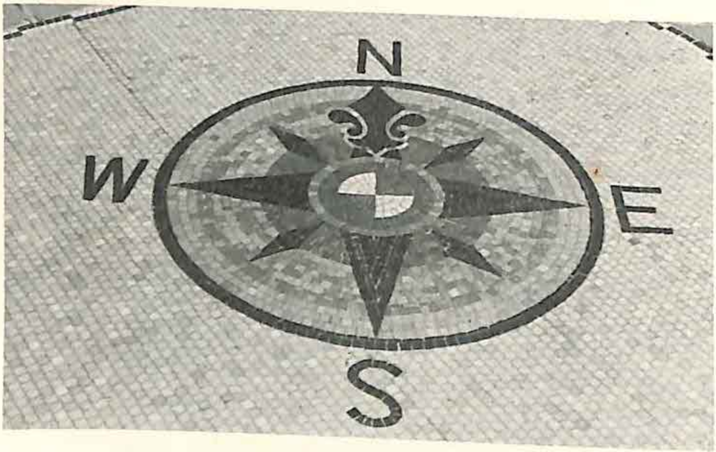
39



This is a picture of a mosaic. It is made up of a set of tiles.
Each tile $\in$ {tiles used in mosaic}
Go on to the next frame.

38
W IS A SUBSET
OF P

40



This is a picture of a PART of the mosaic.
It is made up of many tiles, but it is a PART of the complete mosaic.
We say that this PART is a sub* * * of {tiles used in mosaic}

41 The sets can be named:

M = {tiles used in mosaic} P = {tiles forming compass points}

We can now say that * is a subset of * .

40
SUBSET

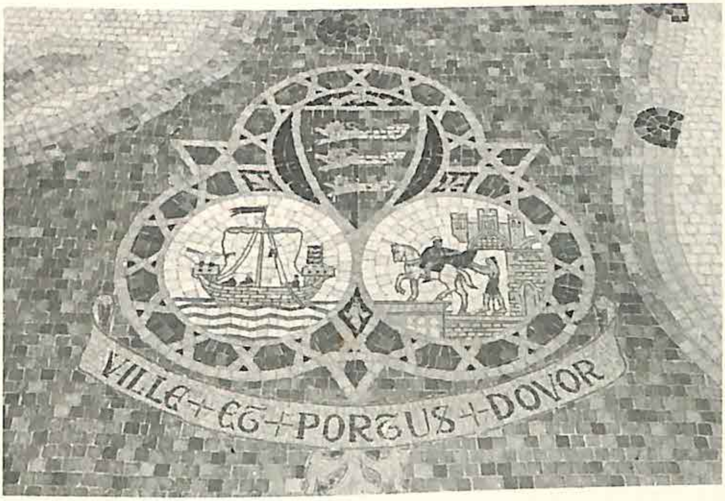
---

42 P is a subset of M, and can be written * * * .

41
P M

---

43 This is a photograph of another *part* of M.



It shows the set of tiles used to form the coat of arms.
We will call this set A.
A is a s—— of M.

42
$P \subset M$

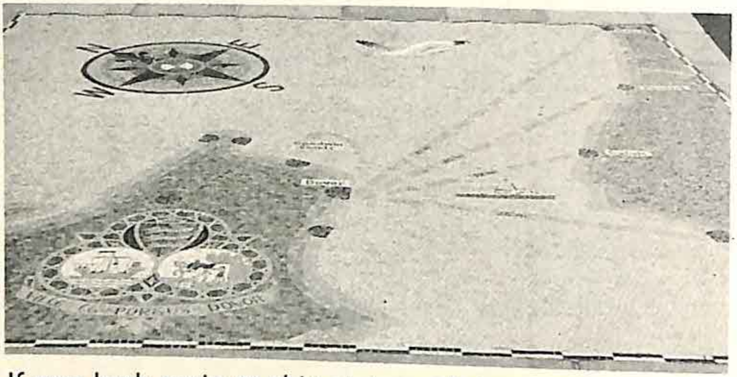
---

44 A is a subset of M can be written—

A * M.

43
SUBSET

45



If you look again at this picture of the mosaic, you will see that there are many subsets.

$D = \{$ tiles used to make Dover$\}$
$S = \{$tiles used to make ships$\}$
$G = \{$tiles used to make seagull$\}$
$F = \{$tiles used to make Calais$\}$

All these sets are subsets of M.

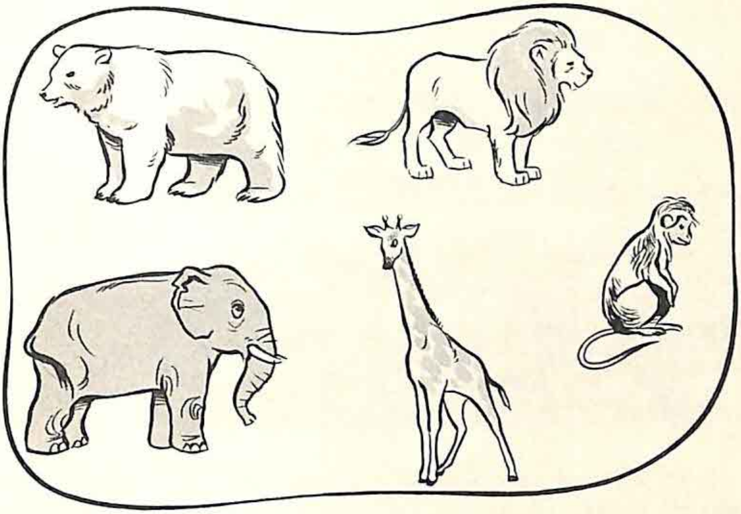
Complete each of these mathematical sentences—

(*a*) $D \subset *$. (*b*) $G * M$.

44
$\subset$ OR $A \subset M$

45
(*a*) M or $D \subset M$
(*b*) $\subset$ or $G \subset M$

Review Section 2



This represents a set of wild animals.
A is the name of this set.
$A = \{\text{bear, lion, elephant, giraffe, monkey}\}$
Below are some other sets which may or may not be SUBSETS of A.

$B = \{\text{lion}\}$ $C = \{\text{giraffe, monkey, tiger}\}$
$D = \{\text{seal}\}$ $E = \{\text{monkey, bear}\}$
$F = \{\text{elephant, zebra}\}$

Here are some mathematical sentences. Write down whether each one is true or false.

1 $A \subset B$ 2 $B \subset A$ 3 $C \subset A$
4 $D \subset A$ 5 $E \subset A$ 6 $F \subset A$

Now check your answers with those below.

4 FALSE 1 FALSE 3 FALSE 6 FALSE
5 TRUE 2 TRUE

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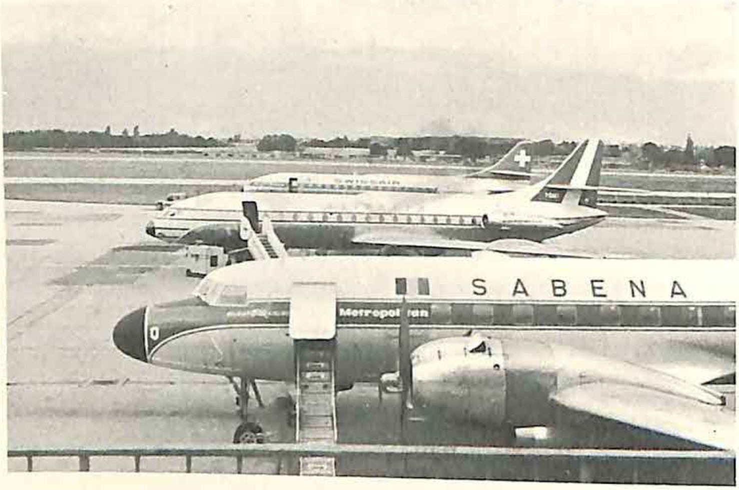
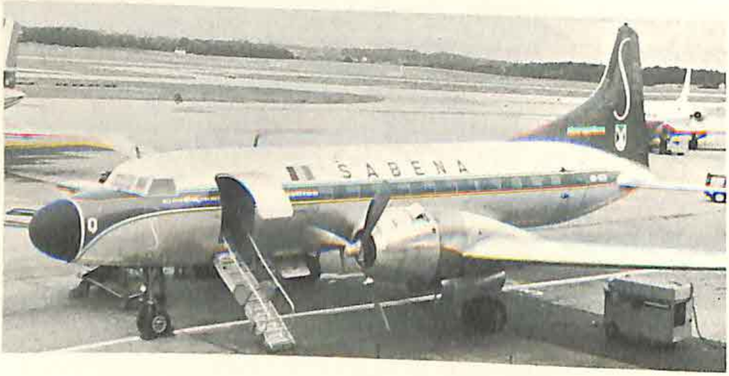


This picture shows a set of aeroplanes. We will call it A. How many aeroplanes are there in A?

47

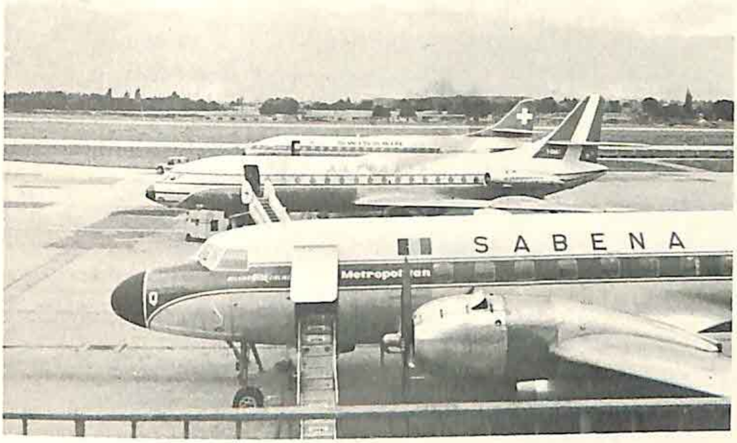


Here is just one part of A. It is a subset of A and we will call it S.

S * A

Which sign is needed to make this sentence read, "S is a subset of A"?

46
3



47
C

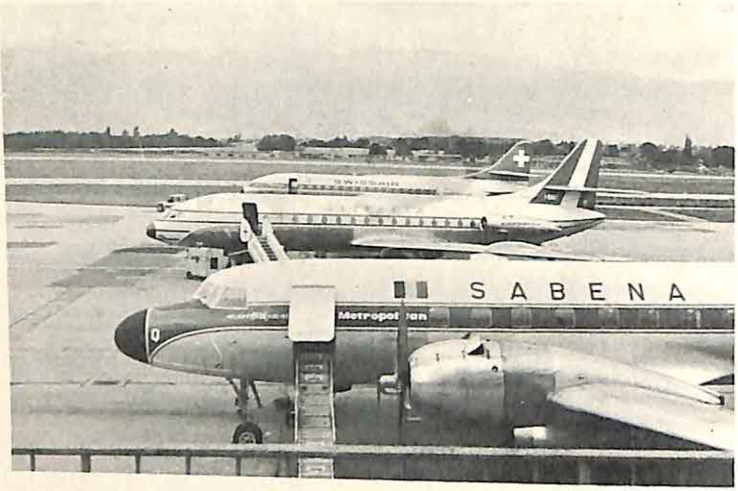
48 This is set A.
There are 3 aeroplanes in A.
J = {jet aeroplanes}
Is J a subset of A?

48
YES

49 The Sabena aircraft is not a jet. It has a piston engine.
S = {aircraft with piston engines}
$S \subset A$. Is this a true statement?

49
YES

Review Section 3



This picture shows set A again.
There are many subsets of A which are sets themselves.

J = {jet aeroplanes}
M = {Metropolitan aircraft}
B = {Alitalia Caravelle}
C = {Caravelle aircraft}
I = {Swissair Caravelle}
S = {aircraft with piston engines}

Below are a number of mathematical sentences.
Write down whether each one is true or false.

1 Sabena aircraft $\in$M
2 M $=$ S
3 I$\subset$C
4 Alitalia aircraft $\in$S
5 B$\subset$J
6 Which one of these sentences is false?
(*a*) S$\subset$A (*b*) C$\subset$J
(*c*) I$\subset$J (*d*) A$\subset$B

Now check your answers with those below.

3 TRUE 5 TRUE 1 TRUE 6 (*d*)
4 FALSE 2 TRUE

Test 1

1 A set is a * * * * * * * * * * .

2 A subset is p * * * of a set.

3 A capital letter is used to —— a set.

4 We can *describe* a set by giving its ———————— ————.

5 The things which make up a set are called the ————.

6 The NATURAL numbers are the numbers we use when we are ————.

7 NATURAL numbers must be w—— numbers.

8 $\{\text{odd numbers}\} \subset \{\text{natural numbers}\}$
Write out this mathematical sentence IN FULL, *using only words*.

Here are three sets:
$N = \{\text{natural numbers}\}$ $O = \{\text{odd numbers}\}$
$E = \{38\}$
Below are four mathematical sentences which refer to the three sets above. Choose the signs needed to turn them into true statements and write out the complete statements.

9 O * N
10 18 * O
11 E * N
12 18 * N

50 When we talk about sets, we usually think about a number of things which have a particular CHARACTERISTIC PROPERTY.

All the elements of this particular set make up the UNIVERSAL SET.

(UNIVERSAL is pronounced *you-ni-verse-al.*)

For instance, if you were thinking of {boys in your class} the UNIVERSAL SET might be {children in the class} or {boys in school} or {boys in the world}.

There might be many UNIVERSAL SETS—the one you choose will depend on the problem you are trying to solve.

The UNIVERSAL SET contains all the e———.

---

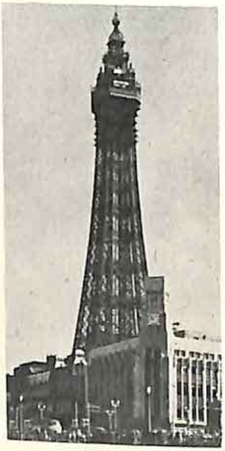
51 Some Universal Sets are very large, some are small. The size of the Universal Set will depend completely on the problem you are working with.

The Universal Set of all numbers has many e———.

50 ELEMENTS

---

52 The Universal Set of Blackpool Tower has — element.



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51 ELEMENTS

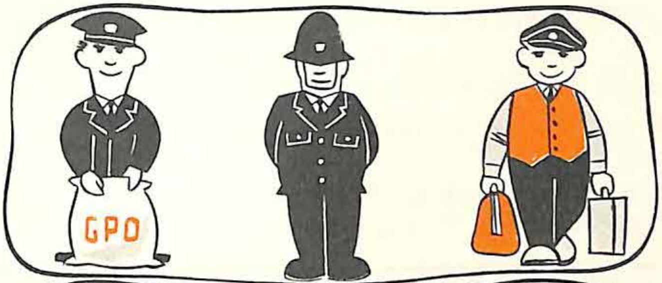
---

53 The Universal Set is named **U**.

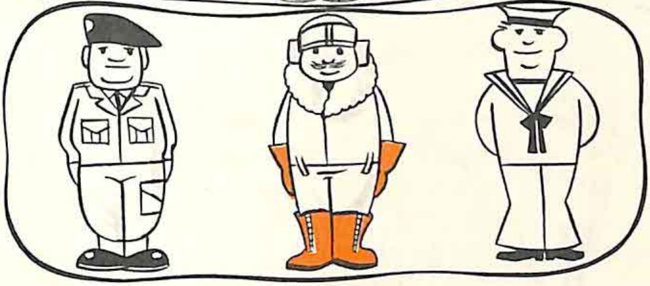
U will contain — the elements of your problem.

52 ONE OR 1

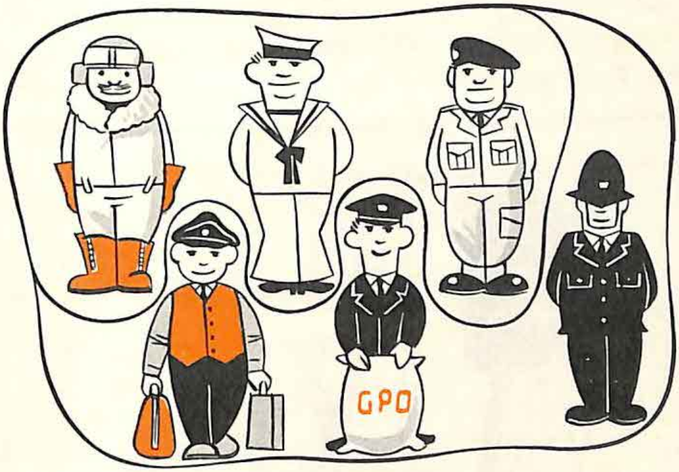
W



F



Here are two sets. The top one is named W.
The lower one is named F.



The two sets are now one. How many elements are there altogether?

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55 If two things are UNITED or JOINED, then a UNION is made.

(UNION is pronounced *you-ni-on.*)

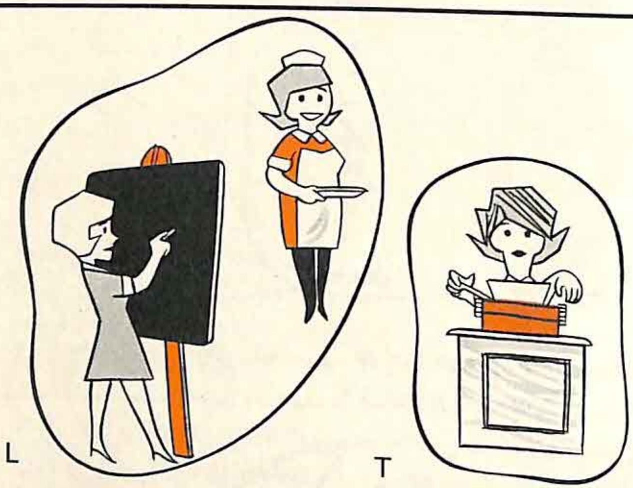
If 2 sets are JOINED or PUT TOGETHER, the result is the UNION OF the 2 sets.

In frame 54, set W was joined with set F.

The result was the u—— of sets W and F.

54
6

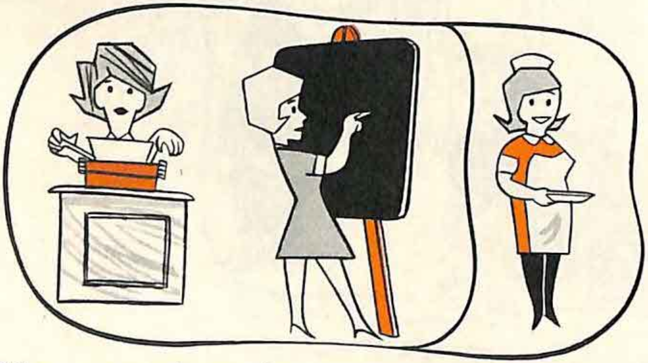
56



Here are two sets. Their names are * and *.

55
UNION

57



This new set shows the —— of sets * and *.

56
L T

58 We will think about the result of uniting or joining different sets.
Here is the set of all the *even* numbers *less* than 11—
{2, 4, 6, 8, 10}
Here is the set of all the *odd* numbers *less* than 11—
{1, 3, 5, 7, 9}
If these two sets are united, the result will be the set of NATURAL numbers ——— ——— —.

57
UNION
L T

---

59 The set of natural numbers less than 11 is
{*, *, *, *, *, *, *, *, *, **}

58
LESS THAN 11

---

60 The set of ten numbers less than 11 which is the result of uniting the set of *even numbers* and the set of *odd numbers less than eleven* is said to be the UNION set of the two sets. If two sets are united we have the un * * * * * * of the two sets.

59
1, 2, 3, 4, 5, 6, 7, 8, 9, 10

---

61 $3 + 4 = 7$
This is a mathematical sentence.
The sign, +, tells us to * * * the two numbers to get the result of 7.

60
UNION SET

---

62 We use a sign, $\cup$, to show that we have united two sets. The sign, $\cup$, which stands for * * ion, looks like a capital letter U.

61
ADD

---

63 A = {even numbers less than 11}
B = {odd numbers less than 11}
A is a set. B is a set.
If we unite A and B the result is ANOTHER SET.
The new set is called A∪B and this is read as "the union of sets * and *", or "the set of elements of sets * and *."

62
UNION

S.C.E.R.T., W.B. LIBRARY
Date ....
Accn. No. ....
S.C.E.R.T., West Bengal
Library

64 $A = \{2, 4, 6, 8, 10\}$ $B = \{1, 3, 5, 7, 9\}$
$A \cup B = \{*, *, *, *, *, *, *, *, *, **\}$

65 + is the sign for addition.
$\cup$ is the sign for the union of * * * *.

66 $C = \{$natural numbers *less* than 5$\}$
$D = \{$natural numbers greater than 5 and *less* than 8$\}$
$C \cup D = \{*, *, *, *, *, *\}$

67 You did very well if your answer to frame 66 was correct. I hope that 5 did not come into your answer, because $5 \notin C$ and 5 * D.

68 The characteristic property of the numbers in D was that they were ——— than 5 and ——— than 8.

69 $C \cup D$ is the *name of the set* you have if you * * * * * sets C and D.

70

F =

F is the NAME of this set. The set has 3 elements.
The number of elements in a set is known as the number of the set.
The NUMBER of this set is **3** because it has **3** elements.
The *number* of a set is written in this way –
n (F) = 3   "n" stands for number.
"(F)" stands for the name of the set.

This frame is continued on the next page

63
A B
A B

64
1, 2, 3, 4, 5,
6, 7, 8, 9, 10

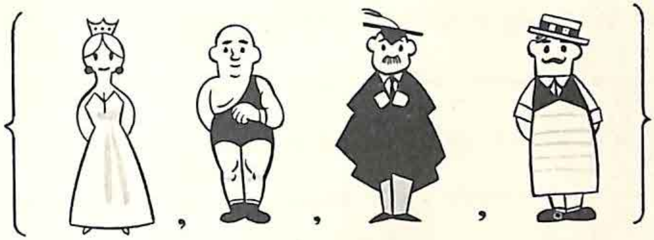
65
SETS

66
1, 2, 3, 4, 6, 7

67
$\in$

68
GREATER OR
MORE; LESS

G =

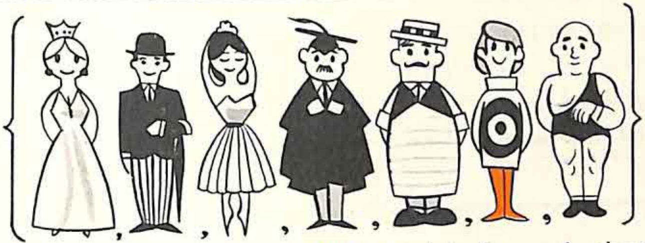


n (G) = *

69
UNITE

71

F∪G



F∪G is the *name* of the new SET which is formed when F and G are united.

F∪G has * elements.

70
4

---

72 All the elements of F are *different from* the elements of G.

To find the NUMBER of a new set which is formed when two sets are united, you must count all the elements of the first set together with all those of the second **which were not already in the first set.**

IF ANY ELEMENTS ARE IN BOTH SETS, THEY ARE COUNTED ONCE ONLY.

n (F∪G) = *

71
7

---

73 J = {beef, pork, mutton, lamb}

K = {peas, beans, carrots, turnips, sprouts}

n (J) = * n (K) = *

72
7

---

74 n (J∪K) = *

73
4 5

---

75 REMEMBER J∪K is the * * * * of a *set*.

74
9

76 $J \cup K$ is the result of *uniting* sets * and *.

75
NAME

---

77 $J \cup K$ is read as: "the u—— set of sets J and K".

76
J (AND) K

---

78 $L \cup M$ is also read as: "the set of *elements of L* united with the set of *elements of M*".
One important point to remember is that *any one element* is only listed in a set ONCE.
If an element is in set L and THE SAME ELEMENT is in set M, in $L \cup M$ the element will be written only ——.

77
UNION

---

79 Here is an example showing two sets having some elements in common:

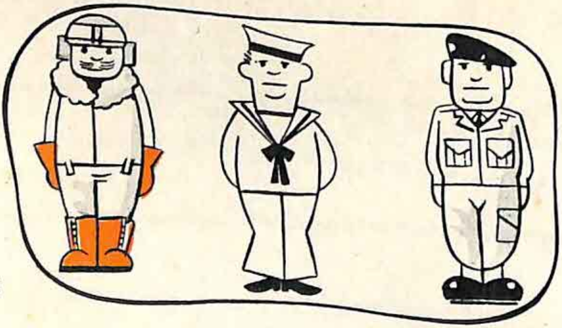
$L = \{1, 2, 3, 4, 5\}$ $M = \{3, 4, 5, 6, 7\}$
$L \cup M = \{1, 2, 3, 4, 5, 6, 7\}$

The elements 3, 4, 5, which are in both L and M, appear ONCE only in $L \cup M$.

$N = \{5, 10, 15\}$ $O = \{15, 20, 25\}$
$N \cup O = \{*, **, **, **, **\}$

78
ONCE

80



F

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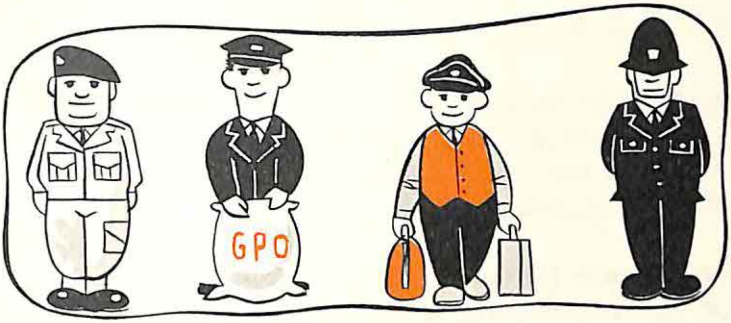


M

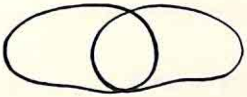
Which element is in both set F and set M?

79

5, 10, 15, 20, 25

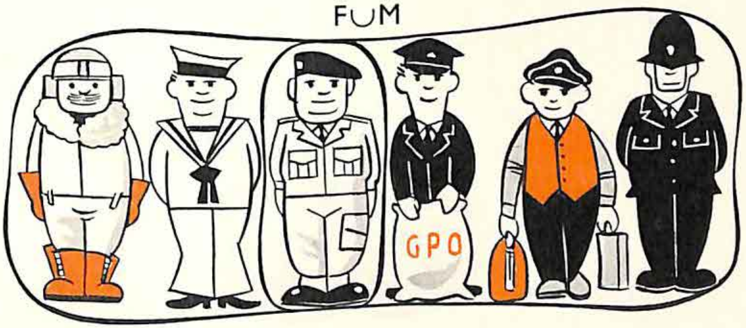
---

81 To show the UNION of these two sets, the closed curves will be drawn in this way:



The soldier is in the centre section because he belongs to both sets.

F∪M



n (F) = * n (M) = * n (F∪M) = *

80

THE SOLDIER (YOUR ANSWER SHOULD MEAN THE SAME)

81

3 4 6

Review Section 4

Here are 4 sets:

A = {cat, dog, hamster, mouse}
B = {rabbit, snake, goldfish, budgerigar}
C = {hamster, snake, tortoise}
D = {goldfish, cat, dog, goat}

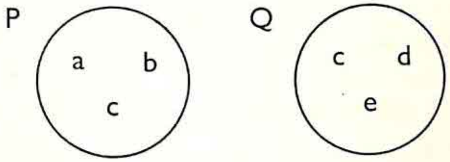
Here are some examples for you to do.
It is very important to remember that any particular element is listed in the union of sets only ONCE.

1 $n(A) = *$ $n(B) = *$ $n(A \cup B) = *$
2 $n(C) = *$ $n(A \cup C) = *$
3 $n(D) = *$ $n(B \cup D) = *$
4 $n(D \cup C) = *$
5 $n(A \cup B \cup C) = *$

Now check your answers with those below.

3 $n(D) = 4$ $n(B \cup D) = 7$ 5 $n(A \cup B \cup C) = 9$
1 $n(A) = 4$ $n(B) = 4$ $n(A \cup B) = 8$
2 $n(C) = 3$ $n(A \cup C) = 6$ 4 $n(D \cup C) = 7$

82 We can use diagrams to show the union of sets.
$P = \{a, b, c\}$ $Q = \{c, d, e\}$
We can represent sets P and Q like this:



What sign will stand for the UNION of P and Q?

---

83 How many elements will be in the UNION of P and Q?
Write it in this form—
$n\ (P \cup Q) = *$

82
$P \cup G$ (THINK OF THIS AS ONE SET)

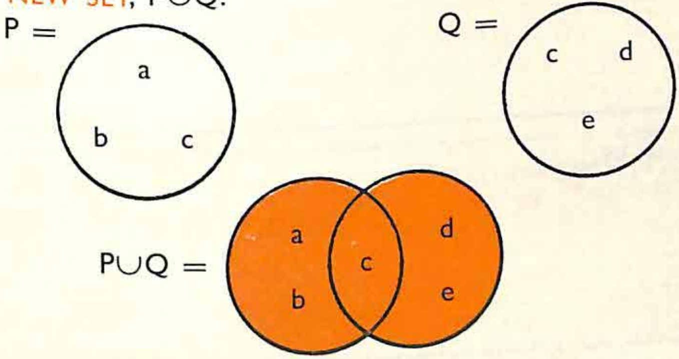
---

84 $P \cup Q = \{*, *, *, *, *\}$

83
$n\ (P \cup Q) = 5$

---

85 The diagrams must now be made to stand for the NEW SET, $P \cup Q$.



The two circles are now put together WITH AN OVERLAP. The overlap shows that the element c is common to both sets. It appears —— only in $P \cup Q$ and not twice.

Notice that the two circles are now coloured.

84
$\{a, b, c, d, e\}$
or
a, b, c, d, e

86 Here are two sets and I want you to draw a diagram to represent their UNION.

T = {apple, orange, grape}
W = {lemon, melon, orange}

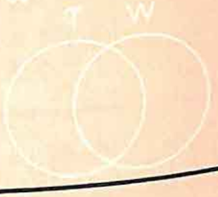
Stage 1 Find if any elements are listed in both sets.
"Orange" is listed in both T and W.
Orange is the element which is COMMON to both sets.
So, the circles must have an overlap.

Stage 2 Draw the circles and NAME them.

85
ONCE

---

87 *Stage 3* Write in the common element.

86


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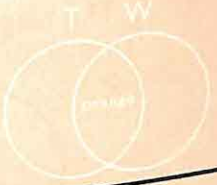
88 *Stage 4* Now complete T.

87


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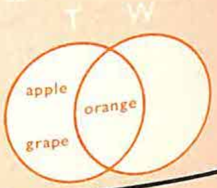
89 *Stage 5* Now complete W.
Do not forget to colour the diagram.

88


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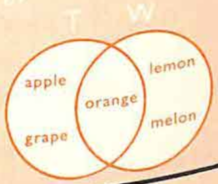
90 The UNION of T and W must have a name.
It is * * *.

89


91 Here are two more sets—

Y = {chair, table, stool, desk}
Z = {cupboard, desk, chest, table}

Now draw a diagram to show the UNION of Y and Z.

Remember the 5 stages—

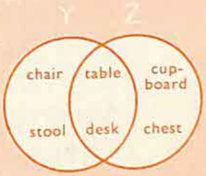
1. Look for any common elements.
2. Draw circles with or without overlap, and name them.
3. Put in common elements.
4. Complete Y.
5. Complete Z.

90
T∪W

---

92 The name of the set you have just drawn is * * *.

91



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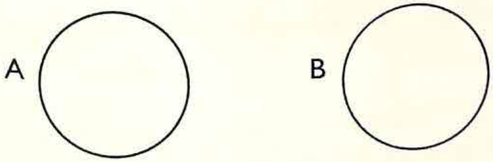
93 Diagrams like the ones we have been using to show the UNION of sets are called VENN DIAGRAMS.
So far we have used circles for our Ve* * diagrams.

92
Y∪Z

---

94 Let us think of 2 sets which have **no common element.**

A = {plum, strawberry, pear}
B = {damson, peach, cherry}



Because there is no common element, the 2 circles are not joined.

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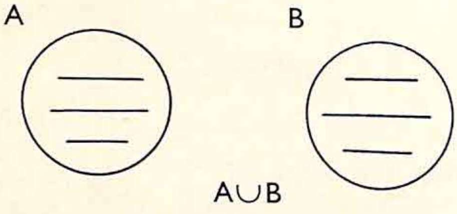
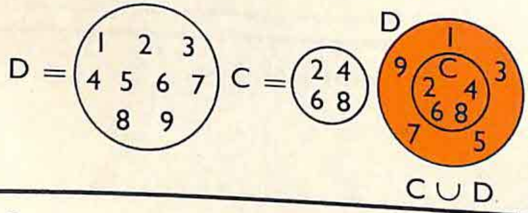
93
VENN

They are drawn separately and then the elements are written in.



Now draw A∪B.

95 Remember it is the SPACE INSIDE THE CIRCLES which represents the sets.
This is seen in the next diagram.
C = {even numbers less than 10}
D = {natural numbers less than 10}
The even numbers *less than* 10 are 2, 4, 6, 8.
So, C = {2, 4, 6, 8}
Natural numbers *less than* 10 are 1, 2, 3, 4, 5, 6, 7, 8, 9.
So, D = {1, 2, 3, 4, 5, 6, 7, 8, 9}
All elements of C are in D, so, C⊂D
(This is read as: C is a subset of D.)
Here are the VENN DIAGRAMS:

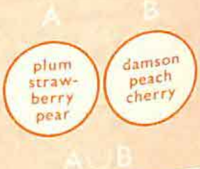


C is drawn *inside* D because all the elements of C are also * * * * * * * * of D.

96 Because all the elements of C are in D, C is a ——— of D.

97 It may be necessary to show the UNION of two equal sets.
Sets are equal when their elements are exactly the ——.

94

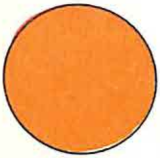


95
ELEMENTS

96
SUBSET

98 $Y = \{\text{even numbers}\}$ $Z = \{\text{multiples of } 2\}$

$Y = Z$



This represents the UNION of Y and Z because all the elements of both sets are the same.

$Y \cup Z$

To make a Venn diagram, how many circles are needed to show the UNION of two EQUAL sets?

97
SAME

---

99 To make a Venn diagram, how many circles are needed to show the UNION of two sets which have NO COMMON ELEMENTS ?

98
ONE OR 1

---

100 To make a Venn diagram, two circles will have an overlap if one or more of the elements are members of ______ sets.

99
TWO OR 2

100
BOTH

Test 2

I would like you now to practise finding set unions. The sets to work with are written in pairs. Find the UNION of each pair. For instance—
find the UNION of A and B, then of C and D, and so on. Draw Venn diagrams to represent the sets.
Remember to name the new set each time.

1 A = {2, 4, 6}
B = {4, 8, 12}

2 C = {Peter, John, David}
D = {Bill, Tom, David}

3 E = {potato, pea, bean}
F = {carrot, turnip, cabbage}

4 G = {ship, train, bicycle}
H = {train, ship, bicycle}

5 I = {ink, paint, chalk, crayon}
J = {chalk, ink}

6 K = {green, blue, yellow, red}
L = {red, yellow, blue}

101 This signpost shows that two roads meet. The place at which the two roads meet is the INTERSECTION (pronounced *in-ter-sec-shun*).

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An INTERSECTION is a meet * * * pla * *.

102

This photograph shows the intersec * * * * of the two roads.

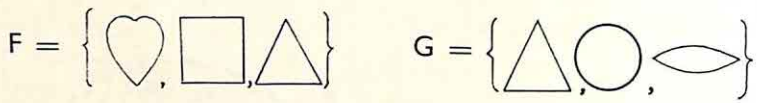
---

103 Sets can also meet or intersect and the INTERSECTION is the set formed AT THE MEETING PLACE.
REMEMBER—the INTERSECTION is a s * *.

101
MEETING PLAC

102
INTERSECTION

104 Here are two sets—



The MEETING POINT of the two sets is the COMMON ELEMENT.

The common element is *.

103
SET

105 The INTERSECTION of F and G is the set containing this common element, *.

104
△

106 Here are another two sets—
H = {John, Peter, Ann}   I = {Ian, Michael, Ann}
Ann is the common element.
{Ann} is the inter——— of H and I.

105
△

107 J = {Robert, David, Janet}   I = {Ian, Michael, Ann}
In these two sets there is no common element.

Sets which have *no* common element are said to be DISJOINT.

If sets are DISJOINT they have no * * * * * section.

106
INTERSECTION

108 H = {John, Peter, Ann}   J = {Robert, David, Janet}
These sets are disj * * * t because they have no common ———.

107
INTERSECTION

109 Remember that the meeting point or ——— of two sets is another set.

108
DISJOINT;
ELEMENT

110 We must name sets, so we need another sign to show an intersection.
It is this: $\cap$.
$H \cap J$ is read as: "*the set of* elements of H which are also elements of J".
Write the letters and sign which would name the intersection of sets K and L.

109
INTERSECTION

---

111 Look at the two sets in frame 108.
The intersection of these two sets has *no* element.
This is because the sets are DISJOINT.
$H \cap J$ (the intersection of sets H and J) is a NULL or EMPTY SET.
We write this as—
$H \cap J = *$

110
$K \cap L$

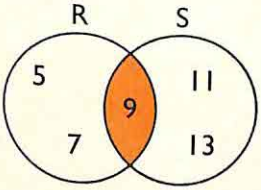
---

112 You did very well if your answer to frame 111 was correct.
In this case, the null set is the intersection of d——t sets.

111
$\varnothing$ OR $\{\ \}$
OR ⬭

---

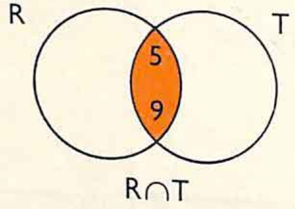
113 Venn diagrams are also used to show INTERSECTIONS.
Here are two sets—
$R = \{5, 7, 9\}$ $S = \{9, 11, 13\}$



The coloured section of this Venn diagram shows the intersection.
$R \cap S = \{*\}$

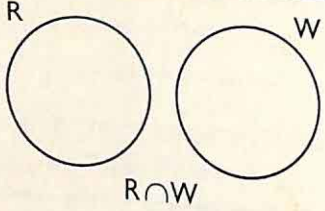
112
DISJOINT

114 $R = \{5, 7, 9\}$ $T = \{5, 9, 14\}$ $R \cap T = \{*, *\}$

115


R and T are from frame 114.
$R \cap T = \{*, *\}$

116 $R = \{5, 7, 9\}$ $W = \{4, 6, 8\}$ $R \cap W = *$

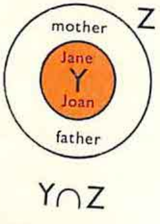
117


This Venn diagram represents the intersection of sets R and W.
This time there is no coloured part. This shows there is no inter———.

118 It is possible to have an intersection where one set is a subset of another set.
$Y = \{\text{Jane, Joan}\}$
$Z = \{\text{Mary, Helen, Jane, Joan}\}$
$Y \subset Z$ this says Y is a ——— of Z.

119 Another way of saying Y is a subset of Z is, Y is incl * * * * in Z.

120 $Y \cap Z = \{\text{———}, \text{———}\}$

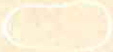
121


The intersection, coloured red, is inside Z because Y is a ——— of Z.

113
9

114
5, 9

115
5, 9

116
∅ OR { }
OR

OR NULL SET

117
INTERSECTION

118
SUBSET

119
INCLUDED

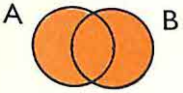
120
JANE, JOAN

122 This is a good time to have a little revision on the use of three signs.

⊂ This sign means "is a subset of".
It is like a letter C and a subset is Contained in a set.

∪ This sign means "the union of".
It is like a letter U and means "Union".

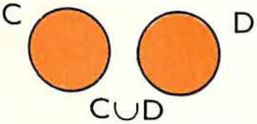
∩ This sign means "the intersection of".
There is no easy way to remember this sign.



This Venn diagram represents the UNION of sets A and B. It is A * B.

121
SUBSET

123



This Venn diagram represents the UNION of sets C and D.

Here are three pairs of sets—

(*a*) C = {1, 2, 3} D = {3, 4, 5}
(*b*) C = {7, 8, 9} D = {14, 15, 16}
(*c*) C = {20, 30, 40} D = {20, 30, 40}

Which pair of sets is represented by the Venn diagram above?

122
∪ OR A∪B

---

124 You did well if your answer to frame 123 was correct. Remember that *the inside of the two circles* represents a u——.

123
(*b*)

---

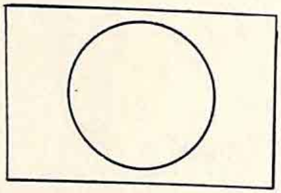
125 The two circles were separate in frame 123 because the two sets had no c—— e——.

124
UNION

126 Common elements are elements which are the ——.

125
COMMON ELEMENTS

127

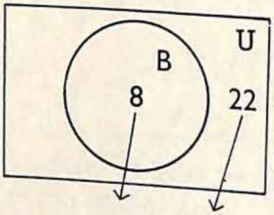


This diagram shows the last stage you need to know in order to draw complete Venn diagrams.

The circle is drawn inside the rectangle because the rectangle represents the Universal Set.

A very simple example will help to explain.

In a class of 30 children, 8 children own bicycles.
U = {children in class}
B = {children in class who own bicycles}



n(U) = 8 + 22 = 30

(*a*) This Venn diagram now shows that there are * * children in the whole class.
(*b*) There are * children who own bicycles.
(*c*) There are * * children who do not own bicycles.

126
SAME

127
(*a*) 30
(*b*) 8
(*c*) 22

Review Section 5

You can now practise drawing simple Venn diagrams. Draw Venn diagrams to show the following:

1 U = {bees in a hive}
n (U) = 20,000
Q = {Queen Bee}
n (Q) = 1

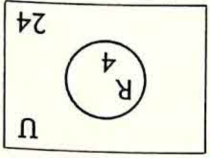
2 U = {kinds of sweets in a shop}
n (U) = 56
C = {kinds of sweets made of chocolate}
n (C) = 16

3 U = {all types of bicycles for sale}
n (U) = 74
M = {red cycles for sale}
n (M) = 16

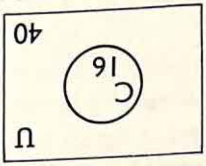
4 U = {colours in a tray}
n (U) = 8
B = {colours made from blue in a tray}
n (B) = 3

5 U = {children in class}
n (U) = 28
R = {red-haired children in class}
n (R) = 4

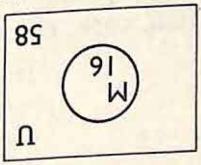
Now check your answers with those below.



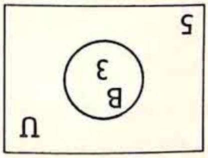
5



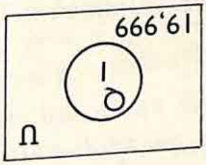
2



3



4



B

1

Test 3

You now need some practice in working out the INTERSECTION of sets.
Once again, the sets are written for you in pairs.
Find the intersection of each pair.
Show the intersections by drawing Venn diagrams.
Write down all the elements in their correct sections in the Venn diagrams.
Colour *the intersections* where necessary.

Remember to name the new set each time.

1 A = {○, ♡, △}   B = {□, ✳, ○}

2 C = {1, 2, 3, 4, 5}
D = {2, 4, 6, 8}

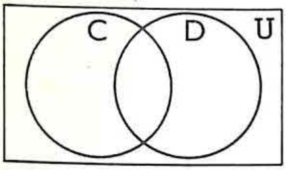
3 E = {5, 10, 15, 20, 25}
F = {5, 15, 25}

4 G = {ash, oak, elm, fir, pine}
H = {fir, pine}

5 I = {violet, poppy, daisy}
J = {apple, plum, cherry}

6 K = {cat, chicken, dog}
L = {hen, cock, chicken}

128



Here is another example.

The rectangle represents the Universal Set which is
{children who eat school dinners}
$C = \{$children who like meat$\}$
$D = \{$children who like fish$\}$
$C \cap D = \{$children who like meat *and* fish$\}$
$n(U) = 24$ $n(C) = 9$ $n(D) = 12$ $n(C \cap D) = 4$

Now draw the Venn diagram and put in all the numbers in the sets.

REMEMBER. The number of children who like meat *and* fish, which is the number of the intersection of C and D, are included in the whole of C or of D, **so do not put this number in twice.**

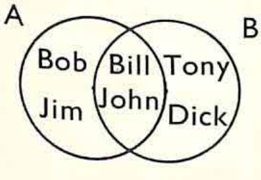
129

You can now try to use your knowledge of sets and Venn diagrams to work out the answers to puzzles.
Take a very simple example first of all.

$A =$ the set of boys who play cricket
$= \{$Bill, Bob, John, Jim$\}$
$B =$ the set of boys who can swim
$= \{$Bill, John, Tony, Dick$\}$

How many boys can both play cricket and swim?

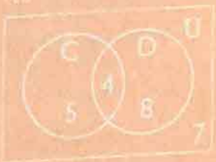
Remember the 5 stages in writing down the Venn diagram.



(*a*) Find common elements.
(*b*) Draw circles with overlap, and name them.
(*c*) Write in common elements.
(*d*) Finish off A.
(*e*) Finish off B.

Now answer the question by looking at the diagram.
How many boys can *both* play cricket and swim?

128



CHECK THIS ANSWER VERY CAREFULLY AND FIND THE REASONS FOR ANY MISTAKES YOU MAY HAVE MADE

130 You can also give the names of the two boys by looking at the diagram. They are —— and ——.

129
2

---

131 To find the answers to frames 129 and 130, did you find $A \cap B$ or $A \cup B$?

130
BILL AND JOHN

---

132 Of course you looked at the *intersection* of A and B; this is $A \cap B$. The number of boys who could *either* swim *or* play cricket *or both* would be *.

131
$A \cap B$

---

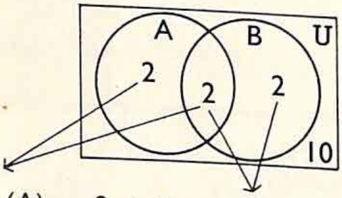
133 The problem in frame 129 could be made slightly more difficult and numbers used instead of names.

$U = \{\text{boys in class}\}$ $n(U) = 16$
$A = \{\text{boys who play cricket}\}$ $n(A) = 4$
$B = \{\text{boys who can swim}\}$ $n(B) = 4$
$A \cap B = \{\text{boys who can } \textit{both} \text{ swim and play cricket}\}$
$n(A \cap B) = 2$

Now draw a complete Venn diagram and write in the numbers into each section. *Do not forget to name the sections*. The answer is in the next frame.

132
6

134



$n(A) = 2 + 2$ $n(B) = 2 + 2$ $n(A \cup B) = *$
$A \cup B = \{\text{boys who can either swim or play cricket or do both}\}$

133
SEE FRAME 134

---

135 The problem in frame 133 says that there are 16 boys in the class and that 4 boys can swim. The set of boys who cannot swim is the COMPLEMENT of the set of boys who can swim.

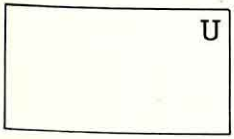
What is the number of {boys who cannot swim}?

134
6

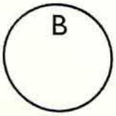
136 *To help you to draw the Venn diagrams, cut a rectangular piece of cardboard 4″ x 3″ and draw the circles around a penny.*

The COMPLEMENT of set B is made up of all the elements of the Universal Set which are not in set B. The sign used to show the complement of a set is a dash placed at the top and to the right of the name of the set.

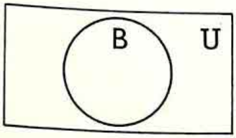
If B is the name of the set, the complement of B is B′.



This is the diagram used to represent the Universal Set.



This is the diagram used to represent set B.



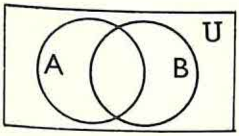
This diagram shows B inside U.

Draw this and colour the complement of B, that is the section of the Venn diagram which shows B′.

135

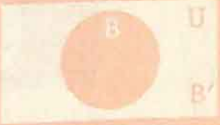
12

137 The complement of a set is made up of *all* the elements which are not part of that set.

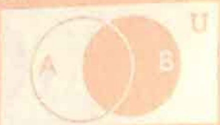


Draw this Venn diagram and colour the section which represents B′.

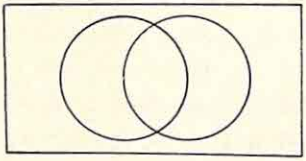
136



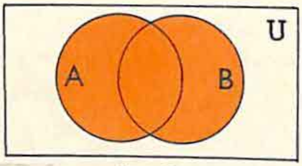
137



Review Section 6



Draw six Venn diagrams like this and colour in the sections of the diagrams which represent the following sets. (The first one is done for you.)



$A \cup B$

The coloured part of this diagram represents the UNION of sets A and B.

1 A

2 $A \cap B$

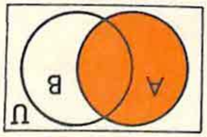
3 U

4 $A \cap A'$

5 B'

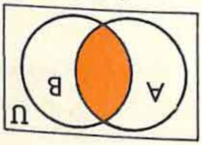
6 A'

Now check your answers with those below.



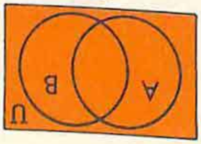
1

A



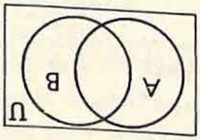
2

$A \cap B$



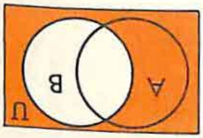
3

U



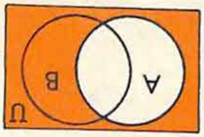
4

$A \cap A'$



5

B'



6

A'

Test 4

Draw Venn diagrams to find the answers to the following problems.

1 In a class of 45 children, 15 children like mathematics, 12 children like geography, and 6 children like *both* subjects. How many children like neither subject?

2 There are 11 men in a cricket team. Some men are good batsmen. 5 men are good bowlers. 2 men are both good batsmen and good bowlers. Only the wicket keeper is neither. How many men are good batsmen *only*?

3 In a box of sweets 24 were made entirely or partly of toffee, 12 were made entirely or partly of chocolate, 6 were made of both toffee and chocolate, 5 were pastilles. How many sweets were in the box?

4 In a hotel 18 people ate bacon for breakfast, 8 ate kippers, 4 ate *both* bacon and kippers, and 5 ate neither. How many people were staying in the hotel?

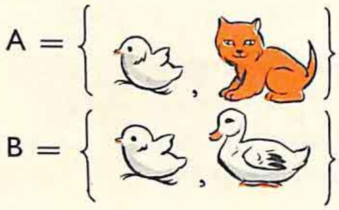
5 A number of people worked in a travel agency. 10 could speak German, 12 could speak French, 5 could speak *both* French and German, 4 could speak Italian *only*. How many people worked in the travel agency?

138 You have now had the opportunity to work out a number of relationships between two sets. Now we will try three.

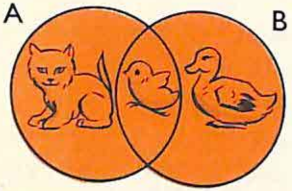
Three, or MORE, sets can be put together in just the same way as two.

If sets are added together we have the u—— of the sets.

139



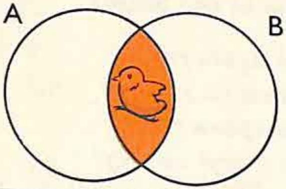
Here are two sets, A and B.



Here is a Venn diagram which shows A∪B.

The common element, *, is shown in both sets.

140



This Venn diagram shows the i———— of A and B.

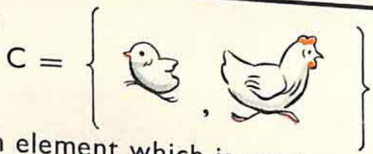
This is written A * B.

---

141 The intersection of sets contains the c—— e——.

---

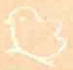
142 Here is a third set.



This set also has an element which is common to A and B. It is *.

138
UNION

139



140
INTERSECTION
∩ OR A∩B

141
COMMON
ELEMENTS

143 The intersection of the three sets is written A∩B∩C and it is equal to {*}

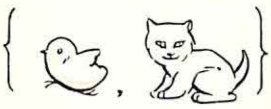
---

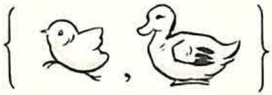
144 The union of sets A and B is written A∪B.
The union of sets A, B and C is written A∪B∪C.
A∪B∪C will be the *name* of the new ——.

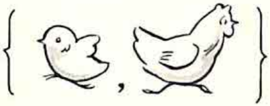
---

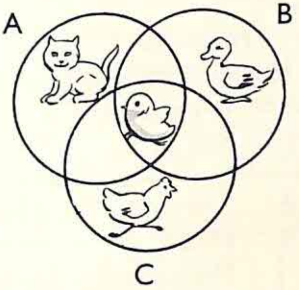
145 Will any element appear in A∪B∪C more than once?

146

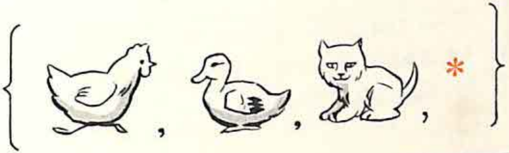
A = 

B = 

C = 



This Venn diagram *shows* the union of sets A, B and C.

A∪B∪C = 

---

147 The intersection of the three sets contains the c——— e———.

---

148 Is there an element common to sets A, B and C?

---

149 Which element is it?

142

143

144
SET

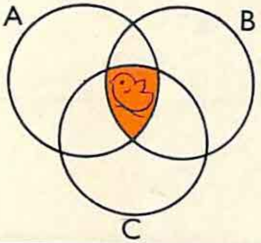
145
NO

146

147
COMMON ELEMENT

148
YES

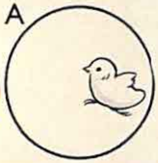
150



This diagram shows the intersection.
The *intersection* of the sets A, B and C is the NAME of this set.
It is written A * B * C.
(Write the whole name.)

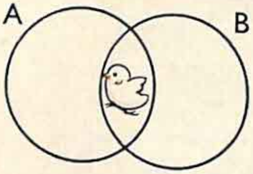
---

151 The next three frames will show how this intersection was made in the diagram.



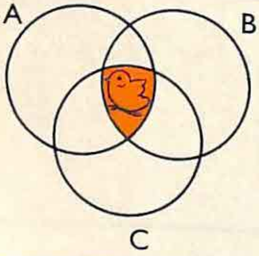
This circle stands for A.
The chicken *only* has been put in because it is the only c——— e——— which is also in B.

152



The circle for B has now been added.
The common element, the ch———, now appears INSIDE BOTH SETS in their INTERSECTION.

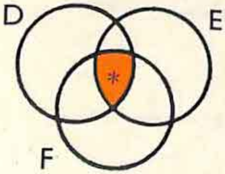
153



The circle for C has now been added.
The common element, the chicken, now appears inside all three sets in their ________.

---

154 D = {2, 4, 6} E = {1, 2, 3, 4} F = {2, 12, 22}



Which element is in the set D∩E∩F?

149

OR (THE) CHICKEN

150

A∩B∩C

151

COMMON ELEMENT

152

CHICKEN OR

153

INTERSECTION

155 $G = \{9, 3, 37\}$ $H = \{4, 3, 12\}$ $I = \{12, 36, 3\}$
$G \cap H \cap I = \{*\}$

154
2

---

156 You will remember that we often describe a set by giving its ch——— p———.

155
3

---

157 This is very useful when we wish to work out the answers to puzzles.

{people who like to eat fruit}

This is a description of a * * * of people.

156
CHARACTERISTIC PROPERTY

---

158 {children in a class who like mathematics}

This desc—— a set of children.

157
SET

---

159 {children in a school who like mathematics}

This describes a set of c———.

158
DESCRIBES

---

160 {Mary, who likes mathematics}

This d——— a — of one c——.

159
CHILDREN

---

161 {children in a school}

This is another set. The sets in frames 158, 159 and 160 could all be sub—— of this set.

160
DESCRIBES;
SET;
CHILD

---

162 It is important to realise that sets of objects or people may have *many* members which have something in common with objects or people in other sets.

Think of {boys in my class}

This is the Universal Set.

A = {boys with blue eyes}
B = {boys who play football}
C = {girls who have fair hair}
D = {boys who like pottery lessons}

Which set could *not* be a subset of the Universal Set?

161
SUBSETS

163 U = {boys in my class}
A = {boys with blue eyes}
B = {boys who play football}
D = {boys who like pottery lessons}

Is it possible for one or several boys to be members of sets A, B, and D?

162
C OR
{GIRLS WHO HAVE FAIR HAIR}

---

164 The three sets, A, B and D can obviously contain any ONE boy who has blue eyes AND can play football AND likes pottery lessons.

There may be MORE than ONE who are members of all three sets.

Is it likely that there will be boys who are members of ANY TWO SETS?

163
YES

---

165 It is also likely that there will be boys who are members of ONLY ONE set.

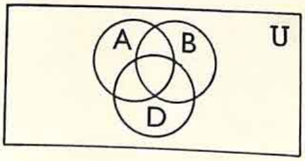
They will be boys who have blue eyes but do NOT play football and do NOT like pottery lessons,

OR boys who play football but do NOT have blue eyes and do NOT like pottery lessons

OR boys who like pottery lessons but do NOT have —— —— and do NOT —— ——.

164
YES

166



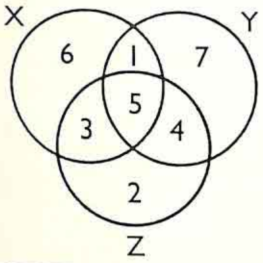
This Venn diagram could be used to find the answers to problems about the sets you have been thinking about.

The part of the diagram inside the rectangle but OUTSIDE the circles would represent the boys who did NOT have —— ——, NOR could they —— ——, NOR did they like —— —— .

165
BLUE EYES;
PLAY
FOOTBALL

167 The frames which follow will show you how the members of three sets and their intersections can be shown.

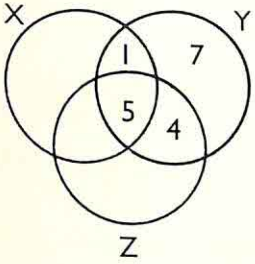
ALWAYS REMEMBER THAT *EVERYTHING* SHOWN INSIDE A LINE PUT AROUND A SET IS A MEMBER OF THAT SET.



How many members has set Y? (Each numeral represents that number of people.)

166
BLUE EYES:
PLAY
FOOTBALL:
POTTERY
LESSONS

168



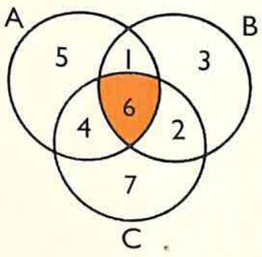
The numerals 1, 7, 5, 4 were all inside the circle which enclosed set Y. The total of the four numbers gives the total number of members of the set. How many members has set X in frame 167?

167
17

169 How many members has set Z?

168
15

170



The coloured part of this diagram shows *the intersection of A, B and C*. It is *.

169
14

171	There is also another part to the intersection of B and C. Which number is in this part?	170 6
172	Because 6 is in B and C and 2 is also in B and C the *total* number of people in the intersection of B and C is 6 and 2 which is *.	171 2
173	6 is also in A and C. What other number is part of A∩C?	172 8
174	The number of people in A∩C is 6 + 4 = * *.	173 4
175	6 is also in A and B. What is the total number in A∩B?	174 10
176	The number in A but NOT in B or C is *.	175 7
177	The number in B but NOT in A or C is *.	176 5
178	The number in C but NOT in A or B is *.	177 3
179	The *total* of *all* the numbers in A is n (A), and n (A) = * *.	178 7
180	The *total* of *all* the numbers in B is n (B), and n (B) = **.	179 16
181	The *total* of *all* the numbers in C is n (C), and n (C) = * *.	180 12
182	n (A∪B∪C) = * *.	181 19
183	Do you find the number of the union of the sets, that is n (A∪B∪C), by adding together n (A), n (B) and n (C)?	182 28

184 No, of course you do NOT.
The number of the union is found by adding:
(*a*) The intersection of all three sets.
(*b*) The remainders of the intersections of any two sets.
(*c*) The numbers left in each set which are NOT part of the others – that is, the numbers left in each set which do not form part of **any** intersection.
Look back at frame 170 and check these three points.
(*a*) n $(A \cap B \cap C) =$ *

183
NO

185 (*b*) n $(A \cap B) =$ * But 6 is already taken for $A \cap B \cap C$, so only * remains.

184
6

186 n $(A \cap C) =$ * * But 6 is already taken for $A \cap B \cap C$, so only * remains.

185
7; 1

187 n $(B \cap C) =$ * But 6 is already taken for $A \cap B \cap C$, so only * remains.

186
10; 4

188 (*c*) The remaining numbers to add to find the total are those in the three sets *which are not part of any intersections*. In A there are * which are not included in intersections with B or C.

187
8; 2

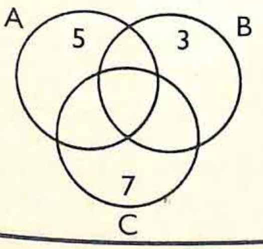
189 There are * in B which are not included in intersections with A or C.

188
5

190 There are * in C which are not included in intersections with A or B.

189
3

191



The answers to the last three frames can easily be checked from this diagram if you did not understand them before. 5 in A, 3 in B, and 7 in C are outside all the inter———.

190
7

192 This use of Venn diagrams makes it easy to find the answers to puzzles which are asked about three or possibly more sets of people or things.

A class of children was asked about their favourite dinners. Here is a list of their replies.

The children enjoyed three dinners: roast beef, stew and fish.

From this we can make out three sets:

B = {children who like roast beef}
S = {children who like stew}
F = {children who like fish}

Now we are given the information about their likes.

1 child liked fish *only*
4 children liked beef *only*
3 children liked stew *only*
4 children liked stew *and* fish
8 children liked beef *and* fish
6 children liked beef *and* stew
2 children liked beef, stew and fish.

How many circles will be needed for the Venn diagram?

---

193 Is there an intersection of all three sets?

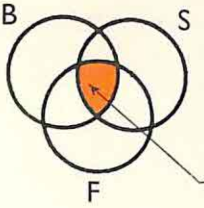
Another way of saying this is—

are there any children who are part of each set?

---

194 You can now draw the Venn diagram *with an intersection of all three sets*. Name the circles and then check the shape.

195



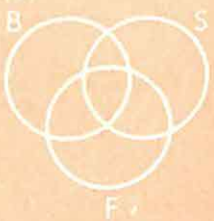
What number will go into $\underbrace{B \cap S \cap F}$?

191
INTERSECTIONS

192
3

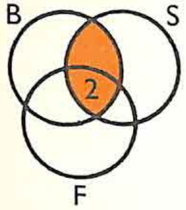
193
YES

194



POSITION OF LETTERS NOT IMPORTANT

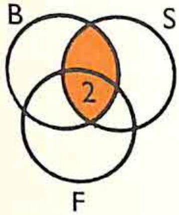
196



2 is in the intersection of the three sets because 2 children like beef, stew and fish.
What is the *total* number of children who like beef and stew?
In other words: What is n (B∩S)?

195
2

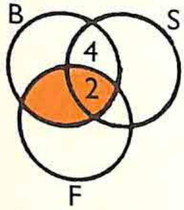
197



The total of B∩S is 6, *but 2 children are already inside this intersection.*
How many more must be put in?

196
6

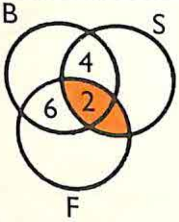
198



Your diagram should now look like this.
Now B∩F can be filled in.
How many *more* will be needed for B∩F? Remember that *there are 2 children in the intersection already.*

197
4

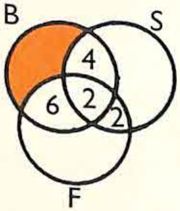
199



Your diagram should now look like this.
Now fill in S∩F. Remember there are already 2 children in S∩F.
How many *more* are needed?

198
6

200



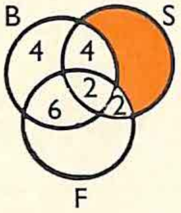
You have now filled in:

(*a*) B∩S∩F
(*b*) B∩F
(*c*) B∩S
(*d*) S∩F

All that remains is to fill in those who only liked one thing.
How many children liked beef only? Put in the number.

199
2

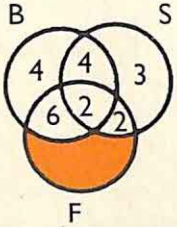
201



How many children liked stew only?
Fill in this number.

200
4

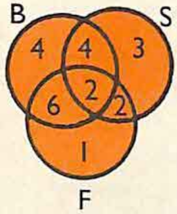
202



Now, last of all, how many children liked fish only?
Fill in this number.

201
3

203



You can now find how many children were asked about their favourite dinners.
How many were asked?

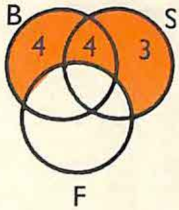
202
1

---

204 If you were wrong check your answer by finding the UNION of the three sets. Now find how many liked beef *or* stew *or* both but *not* fish.

203
22

205



Those who liked beef *or* stew *or* both but *not* fish had to be *outside the circle which represented those who liked fish.*
This is shown in this diagram.

Now find how many liked fish. (They may also like something else, but this does not matter.)

204
11

206 All those who liked fish are *inside the circle representing the set of children who liked fish.* Now find how many liked stew.

205
11

---

207 How many liked beef?

206
11

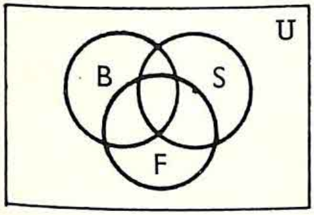
---

208 Now you know how many liked each meal, you can find which one *most* children liked. Which one was it?

207
16

---

209 Now that you know how many children were asked which dinner they liked, you can find how many children were NOT asked if you know how many children were in the class.



This Venn diagram shows this problem.
The circles represent our three sets of children.
The RECTANGLE, inside which the circles are drawn, represents the UNIVERSAL SET from which we have taken the three sets.

Our Universal set in this case is made up of 30 children. We know that 22 children were asked about their favourite dinners. How many were not asked?

208
BEEF

---

210 That is a very easy problem to answer.
If the UNIVERSAL set is 30 and 22 have been taken away from it, 8 must be left.
Some puzzles follow. You should now be able to answer them if you think carefully.

209
8

Puzzles

Now you have worked with Venn diagrams, I hope you will enjoy using them to find the answers to some puzzles.

The first thing to decide, every time, is the number of sets you are working with. You can then draw your diagram.

1 There are 3 sets of children at a party.

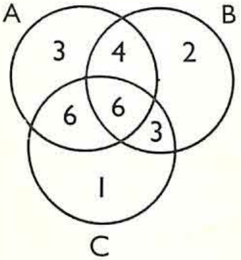
A = {children who like jelly}
B = {children who like ice-cream}
C = {children who like chocolate}

6 children like jelly, ice-cream and chocolate
10 children like jelly and ice-cream
9 children like ice-cream and chocolate
12 children like chocolate and jelly
3 children like jelly *only*
2 children like ice-cream *only*
1 child likes chocolate *only*

(*a*) How many children like jelly?
(*b*) How many children like ice-cream?
(*c*) How many children like chocolate?
(*d*) How many places will be set for all the children at the party?

Check your answers with those on the next page before you continue with the second puzzle.

If you have made any mistakes, find out why you made them before doing the next problem.



(*a*) 19 children
(*b*) 15 children
(*c*) 16 children
(*d*) 25 places.

2 The children in a school were entered on sports day for three kinds of events. There were races, jumps and throwing events.

5 children were entered for races *only*
3 children were entered for jumps *only*
6 children were entered for throwing events *only*
12 children were entered for races *and* throwing events
10 children were entered for races *and* jumps
9 children were entered for jumps *and* throwing events
7 children were entered for *races, jumps and throwing events.*

(*a*) How many children were entered for the races?
(*b*) How many children were entered for the events but were *NOT* throwing?
(*c*) How many children were entered for the events but *NOT* for jumping?
(*d*) How many children were entered for the throwing and jumping events?
(e) How many bus seats were needed for the competitors to take them to the sports ground?

The answers to puzzles 2, 3, 4, 5 and 6 will be found after puzzle number 6 on last page of this book.

3 Certificates are awarded to a class of 40 children.
There are three kinds of certificate:
A certificates for those who can perform one skill only
B certificates for those who can perform two skills
C certificates for those who can perform three skills
5 children could perform all three skills
7 children could swim breast stroke and the crawl
10 children could swim breast stroke and dive
6 children could swim the crawl and dive
15 children, altogether, could swim breast stroke
12 children, altogether, could swim the crawl
14 children, altogether, could dive

(*a*) How many *A* certificates were awarded?
(*b*) How many *B* certificates were awarded?
(*c*) How many *C* certificates were awarded?
(*d*) How many children were awarded certificates?
(*e*) How many children were *not* awarded certificates?

4 Miss Black, Mrs White and Colonel Amber were three people who were listening to pop records in order to choose the top 10.
2 of the records were liked equally by all three people
5 were liked by Colonel Amber and also by Mrs White
4 were voted for by Miss Black and also by Colonel Amber
5 were chosen by Miss Black and also by Mrs White
7 were enjoyed by Miss Black which the other two disliked
6 were liked by Mrs White which the other two did not vote for
Colonel Amber was quite alone in his enjoyment of 7 records

(*a*) How many records did they listen to?
(*b*) How many records did not get into the top ten?

5 A trip is being arranged for the scout football, cricket and rounders teams.

3 of the scouts play all three games
6 play football and cricket
4 play cricket and rounders
5 play rounders and football
3 play football only
4 play cricket only
3 play rounders only

(*a*) Will a coach with 20 seats be big enough to take the scouts *and their scoutmaster*? How many seats will be empty?

(*b*) How many seats will the scoutmaster need to book for a test match for the cricket and rounders teams *and himself*?

(*c*) Certificates are awarded to all the scouts who play for *at least* two teams. How many certificates will be awarded?

6 A number of people was asked which was their favourite holiday resort. Three towns were chosen, Blackpool, Margate, and Skegness.
6 people liked all three, 8 liked Blackpool and Margate, 10 liked Margate and Skegness, and 12 liked Skegness and Blackpool. 5 liked Blackpool only, 3 liked Margate only, and 7 liked Skegness only.

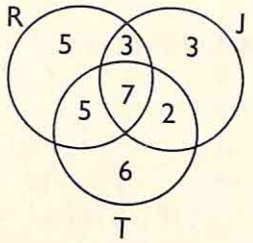
(*a*) How many people were asked?

(*b*) Which town was the most popular?

(*c*) Which town was the least popular?

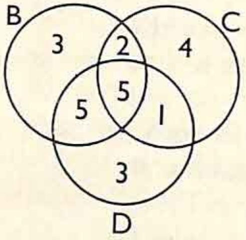
Answers to Puzzles

2



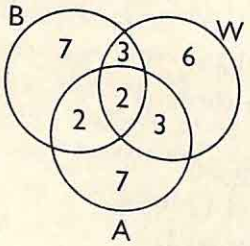
(*a*) 20 children
(*b*) 11 children
(*c*) 16 children
(*d*) 26 children
(e) 31 seats

3



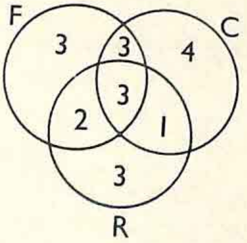
(*a*) 10, A certificates
(*b*) 8, B certificates
(*c*) 5, C certificates
(*d*) 23 children
(e) 17 children

4



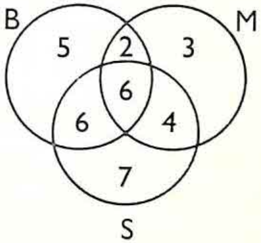
(*a*) 30 records
(*b*) 20 records

5



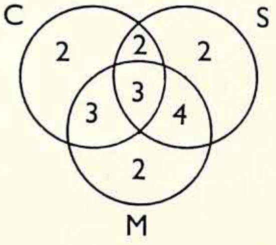
(*a*) Yes
There will be no empty seats, because there are 19 scouts and 1 scout master.
(*b*) 17 seats
(*c*) 9 certificates

6



(*a*) 33
(*b*) Skegness
(*c*) Margate

Answers to Anne's puzzle



(a) 6 bars of chocolate were needed.

(b) 18 scores were recorded.

(c) 9 $\frac{1}{2}$-lb. boxes of chocolates were needed.

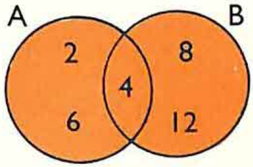
(d) 3 1-lb. boxes of chocolates were needed.

Answers to Tests

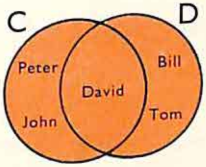
Test 1

1 collection
2 part
3 name
4 characteristic property
5 elements
6 counting
7 whole
8 the set of odd numbers is a subset of the set of natural numbers
9 $O \subset N$
10 $18 \notin O$
11 $E \subset N$
12 $18 \in N$

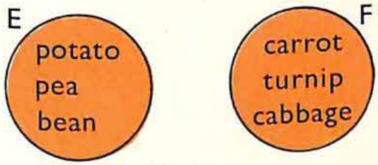
Test 2

1


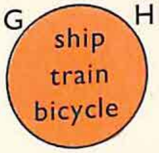
$A \cup B$

2


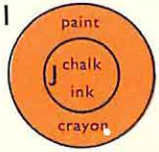
$C \cup D$

3


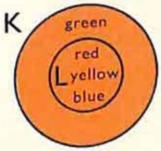
$E \cup F$

4


$G \cup H$

5


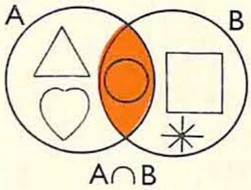
$I \cup J$

6


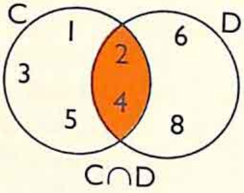
$K \cup L$

Test 3

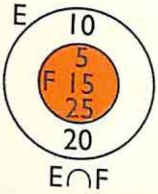
1



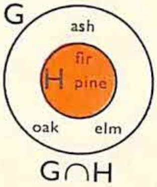
2



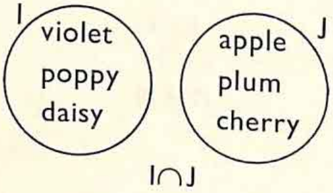
3



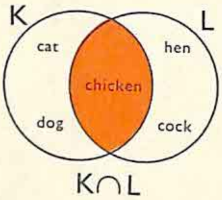
4



5

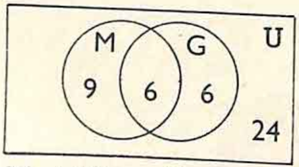


6



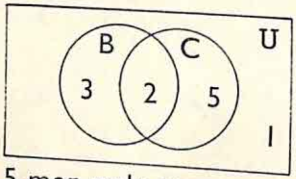
Test 4

1



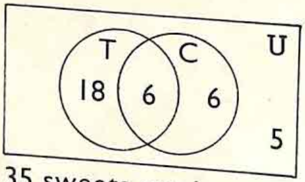
24 children liked neither subject

2



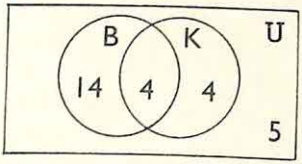
5 men only are good batsmen

3



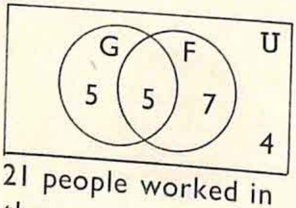
35 sweets are in the box

4



27 people were staying in the hotel

5



21 people worked in the travel agency

Post test

1 A SET is a c———.

2 To *name* a set we usually use a ——— ———.

3 The members or e——— of a set are written inside
   *   *

4 A set can be *described* by writing down what it is that is common to its elements. This is the ——— ——— of the set.

5 Natural numbers are the numbers we use when we c———.

6 The sentence below should say, "3 is an element of the set of natural numbers".
   3 * $\{1, 2, 3, 4, 5, \ldots\}$ Which sign is missing?

7 If set C is a part of set D, C is a s——— of D.

8 $F \subset G$. What does this mathematical sentence say?

9 If two sets are united, the result is another ———.

10 How many times is one particular element listed in a set: once, twice, or any number of times?

11 $A = \{2, 4, 6\}$ $B = \{6, 8, 10\}$
   Write out $A \cup B$ using brackets.

12 Draw a Venn diagram to show the UNION of sets E and F.
   $E = \{\text{Pat, Jim, Joan}\}$ $F = \{\text{Jill, Jim, John}\}$

13 An intersection is a m——— p———.

14 The intersection of two sets is the c——— e———.

15 $G = \{19, 29, 39, 49\}$ $H = \{29, 49, 69, 89\}$
   What is $G \cap H$?

16 I = the set of children who like ice-cream =
{John, Mary, Peter, Anne, David, Andrew}
J = the set of children who like lemonade =
{Pat, Sheila, Mary, Susan, Peter, Martin}
There were 18 children in the class.

Draw a Venn diagram to find the answers to these questions:

How many children liked ice-cream *and* lemonade?

17 Who liked ice-cream and lemonade?

18 Who liked lemonade but not ice-cream?

19 How many people liked neither ice-cream nor lemonade?

20 A number of people was asked which were their favourite radio broadcasts.

Three kinds of programmes were enjoyed: sport, plays and quiz programmes.

16 people listened to sport broadcasts
18 people listened to plays
15 people listened to quiz broadcasts
7 people listened to sport and play broadcasts
5 people listened to play and quiz broadcasts
6 people listened to sport and quiz broadcasts.
3 people listened to all three types of programme.

Draw a Venn diagram to answer the following questions:
How many people listened to sport and play broadcasts but NOT to quiz broadcasts?

21 How many people listened to sport broadcasts only?

22 How many people listened to quiz broadcasts only?

23 How many people listened to any 2 broadcasts, but *not* to 3?

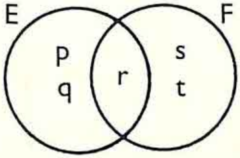
24 How many people were asked which were their favourite broadcasts?

25 How many people who liked quiz broadcasts *also* liked either sport or play programmes?

The answers to this test will be found at the back of the book.

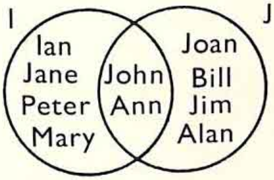
Answers to Pre test

1. collection
2. capital letter
3. elements { }
4. characteristic property
5. count
6. ∈
7. subset
8. Y is a subset of Z
9. set
10. once
11. $A \cup B = \{1, 2, 3, 4, 5\}$

12. 

$E \cup F$

13. meeting place or meeting point
14. common element
15. $G \cap H = \{4, 8\}$

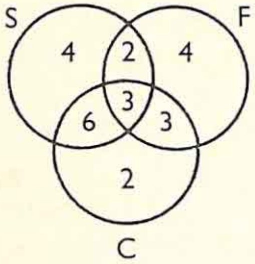
16. 

2 children have fair hair and brown eyes

17. John and Ann
18. Joan, Bill, Jim and Alan
19. 6

Answers to Pre test, continued

20



10

21 4

22 2

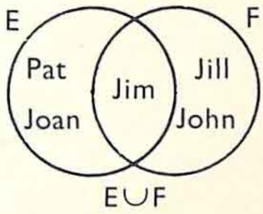
23 11

24 24

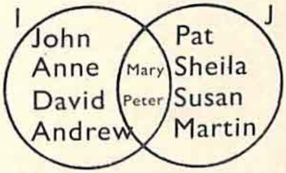
25 12

Answers to Post test

1 collection
2 capital letter
3 elements { }
4 characteristic property
5 count
6 ∈
7 subset
8 F is a subset of G
9 set
10 once
11 $A \cup B = \{2, 4, 6, 8, 10\}$

12


13 meeting place or meeting point
14 common element
15 $G \cap H = \{29, 49\}$

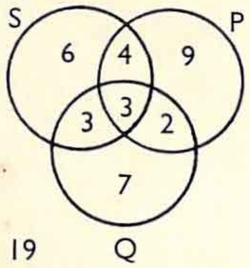
16


2

17 Mary, Peter
18 Pat, Sheila, Susan and Martin
19 8

Answers to Post test, continued

20



21 6
22 7
23 9
24 34
25 8

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